102D CONGRESS
*1st Session*
HOUSE OF REPRESENTATIVES
REPT. 102–66
Part 1

# HIGH-PERFORMANCE COMPUTING ACT OF 1991

MAY 15, 1991.—Ordered to be printed

Mr. BROWN, from the Committee on Science, Space, and Technology, submitted the following

## REPORT

together with

## ADDITIONAL VIEWS

[To accompany H.R. 656]

[Including cost estimate of the Congressional Budget Office]

The Committee on Science, Space, and Technology, to whom was referred the bill (H.R. 656) to provide for a coordinated Federal research program to ensure continued United States leadership in high-performance computing, having considered the same, report favorably thereon with an amendment and recommend that the bill as amended do pass.

CONTENTS

| | Page |
|---|---|
| I. Summary | 7 |
| Background and Need for Legislation | 7 |
| Purpose of the Bill | 8 |
| Budget Explanation | 9 |
| II. Committee Actions | 9 |
| III. Explanation of Committee Amendment | 12 |
| National High-Performance Computing (HPC) Program | 12 |
| National Research and Education Network (NREN) | 13 |
| Roles of Federal Agencies | 14 |
| Authorization of Appropriations | 14 |
| Miscellaneous Provisions | 15 |
| IV. Sectional Analysis of H.R. 656, as Reported | 15 |
| V. Committee Views | 18 |
| 1. High-Performance Computers and Computer Systems | 18 |
| 2. High-Performance Computing Software | 19 |
| 3. A Coordinated, Interagency Program for High-Performance Computing | 20 |
| 4. The High-Performance Computing Advisory Panel | 21 |

49–006

H703-4

5. Characteristics of the National Research and Education Network (NREN) ..... 22
6. Management of the National Research and Education Network (NREN) ..... 23
7. Information Services on the National Research and Education Network (NREN) ..... 23
8. Role of Supercomputing Centers ..... 24
VI. Legislative History ..... 24
VII. Committee Oversight Findings and Recommendations ..... 25
VIII. Oversight Findings and Recommendations by the Committee on Government Operations ..... 25
IX. Congressional Budget Office Cost Estimate ..... 25
X. Impact on Inflation ..... 27
XI. Committee Recommendation ..... 28
XII. Changes in Existing Law Made by the Bill, as Reported ..... 28
XIII. Additional View ..... 29

The amendment is as follows:

Strike out all after the enacting clause and insert in lieu thereof the following:

SECTION 1. SHORT TITLE.

This Act may be cited as the "High-Performance Computing Act of 1991".

SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds the following:

(1) Advances in computer science and technology are vital to the Nation's prosperity, national and economic security, and scientific advancement.

(2) The United States currently leads the world in the development and use of high-performance computing for national security, industrial productivity, and science and engineering, but that lead is being challenged by foreign competitors.

(3) Further research and development, expanded educational programs, improved computer research networks, and more effective technology transfer from government to industry are necessary for the United States to fully reap the benefits of high-performance computing.

(4) Several Federal agencies have ongoing high-performance computing programs, but long-term interagency coordination, cooperation, and planning could enhance the effectiveness of these programs.

(5) A 1989 report entitled "The Federal High-Performance Computing Program" and a 1991 report entitled "Grand Challenges: High-Performance Computing and Communications" by the Office of Science and Technology Policy outlining a research and development strategy for high-performance computing provides a framework for a multiagency high-performance computing program.

(6) Such a program would provide American researchers and educators with the computer and information resources they need, while demonstrating how advanced computers, high-speed networks, and electronic data bases can improve the national information infrastructure for use by all Americans.

(b) PURPOSE.—It is the purpose of Congress in this Act to help ensure the continued leadership of the United States in high-performance computing and its applications through—

(1) the expansion of Federal support for research, development, and application of high-performance computing in order to—

(A) establish a high-capacity national research and education computer network;

(B) expand the number of researchers, educators, and students with training in high-performance computing and access to high-performance computing resources;

(C) promote the further development of an information infrastructure of data bases, services, access mechanisms, and research facilities which is available for use through such a national network;

(D) stimulate research on software technology;

(E) promote the more rapid development and wider distribution of computer software tools and applications software;

(F) accelerate the development of high-performance computing systems and subsystems;

(G) ensure that emerging high-performance computing systems and software technologies are available to researchers for the application to Grand Challenges;

(H) promote the inclusion of high-performance computing into educational institutions at all levels;

(I) ensure that appropriate security controls are implemented; and

(J) encourage cooperative programs between industry and high-performance computing centers to enhance industrial competitiveness; and

(2) the improvement of planning and coordination of Federal research and development of high-performance computing.

SEC. 3. DEFINITIONS.

As used in this Act, the term—

(1) "Director" means the Director of the Office of Science and Technology Policy;

(2) "Grand Challenge" means a fundamental problem in science or engineering, with broad economic and scientific impact, whose solution will require the application of high-performance computing resources;

(3) "high-performance computing systems" means—

(A) current and new generations of scientific workstations;

(B) vector supercomputer systems;

(C) special purpose and experimental computing systems; and

(D) large scale parallel systems,

developed in the private or public sector; and

(4) "Network" means the National Research and Education Network established under section 6.

SEC. 4. MISCELLANEOUS PROVISIONS.

(a) NONAPPLICABILITY.—Except to the extent the appropriate Federal agency or department head determines, the provisions of this Act shall not apply to—

(1) programs or activities regarding computer systems that process classified information; or

(2) computer systems the function, operation, or use of which are those delineated in paragraphs (1) through (5) of section 2315(a) of title 10, United States Code.

(b) ACQUISITION OF PROTOTYPE AND EARLY PRODUCTION MODELS.—As part of the Program described in section 5, and in accordance with Federal contracting law, Federal agencies and departments participating in the Program may purchase or lease prototype or early production models of new high-performance computing systems and subsystems to stimulate hardware and software development. Items of computing equipment acquired under this subsection shall be considered research computers for purposes of applicable acquisition regulations.

SEC. 5. NATIONAL HIGH-PERFORMANCE COMPUTING PROGRAM.

(a) NATIONAL HIGH-PERFORMANCE COMPUTING PROGRAM.—(1) The President shall implement a National High-Performance Computing Program (hereafter in this Act referred to as the "Program").

(2) The Director shall—

(A) submit to the Congress an annual report, along with the President's annual budget request, describing the implementation of the Program;

(B) provide for interagency coordination of the implementation of the Program;

(C) review, prior to the President's submission to the Congress of the annual budget estimate, each agency and departmental budget estimate in the context of the Program and make the results of that review available to the appropriate elements of the Executive Office of the President, particularly the Office of Management and Budget; and

(D) consult with academic, State, industry, and other appropriate groups conducting research on and using high-performance computing.

(3) The annual report submitted under paragraph (2)(A) shall—

(A) describe the goals and priorities for the Program;

(B) set forth the relevant programs and activities, for the fiscal year with respect to which the budget submission applies, of each Federal agency and department, including—

(i) the National Science Foundation;

(ii) the Department of Commerce, particularly the National Institute of Standards and Technology, and the National Oceanic and Atmospheric Administration;

(iii) the National Aeronautics and Space Administration;

(iv) the Department of Defense, particularly the Defense Advanced Research Projects Agency;

(v) the Department of Energy;

(vi) the Department of Health and Human Services, particularly the National Institutes of Health and the National Library of Medicine;

(vii) the Environmental Protection Agency; and

(viii) such other agencies and departments as the President or the Director considers appropriate;

(C) describe the levels of Federal funding for the fiscal year during which such report is submitted, and the levels proposed for the fiscal year with respect to which the budget submission applies, for specific activities, including education, research activities, hardware and software development, and support for the establishment of the Network;

(D) describe the levels of Federal funding for each agency and department participating in the Program for the fiscal year during which such report is submitted, and the levels proposed for the fiscal year with respect to which the budget submission applies; and

(E) include an analysis of the progress made toward achieving the goals and priorities established for the Program.

(4) The Program shall address the security requirements, policies, and standards issued by the Secretary of Commerce necessary to protect national research computer networks and information resources accessible through national research computer networks, including research required to establish security standards for high-performance computing systems and networks. Agencies and departments identified in the annual report submitted under paragraph (2)(A) shall define and implement a security plan consistent with the Program and with applicable law.

(5) The Program shall—

(A) provide for the establishment of policies for management and access to the Network;

(B) provide for oversight of the operation and evolution of the Network; and

(C) ensure the connectivity among computer networks of Federal agencies and departments.

(b) HIGH-PERFORMANCE COMPUTING ADVISORY PANEL.—The Director shall establish a High-Performance Computing Advisory Panel consisting of non-Federal members, including representatives of the research, education, and library communities, network providers, and industry, who are specially qualified to provide the Director with advice and information on high-performance computing. The Director shall consider the recommendations of the Panel in reviewing and revising the Program. The Panel shall provide the Director with an independent assessment of—

(1) progress made in implementing the Program;

(2) the need to revise the Program;

(3) the balance between the components of the Program;

(4) whether the research and development funded under the Program is helping to maintain United States leadership in computing technology; and

(5) other issues identified by the Director.

(c) OFFICE OF MANAGEMENT AND BUDGET.—(1) Each appropriate Federal agency and department involved in high-performance computing shall, as part of its annual request for appropriations to the Office of Management and Budget, submit a report to the Office identifying each element of its high-performance computing activities, which—

(A) specifies whether each such element (i) contributes primarily to the implementation of the Program, or (ii) contributes primarily to the achievement of other objectives but aids Program implementation in important ways; and

(B) states the portion of its request for appropriations that is allocated to each such element.

(2) The Office of Management and Budget shall review each such report in light of the goals, priorities, and agency and departmental responsibilities set forth in the annual report submitted under subsection (a)(2)(A), and shall include, in the President's annual budget estimate, a statement of the portion of each appropriate agency or department's annual budget estimate that is allocated to each element of such agency or department's high-performance computing activities.

SEC. 6. NATIONAL RESEARCH AND EDUCATION NETWORK.

(a) ESTABLISHMENT.—As part of the Program described in section 5, the Director shall coordinate implementation of agency and department activities supporting the broad deployment and use of a national multi-gigabit-per-second research and edu-

cation computer network, to be known as the National Research and Education Network, which shall link research institutions and educational institutions, government, and industry in every State. For purposes of this section, agency activities may include research and development, development of network applications important for research and education, and contracting for services, but shall not include purchasing switches, optical fiber, or any other networking hardware for purposes other than research and development.

(b) ACCESS.—Federal agencies shall work with State and local agencies, libraries, educational institutions and organizations, and private network service providers as appropriate in order to ensure that the researchers, educators, and students have access to the Network. The Network shall provide users with appropriate access to high-performance computing systems, computer data bases, other research facilities, and libraries. The Network shall provide access, to the extent practicable, to electronic information resources maintained by libraries, research facilities, publishers, and affiliated organizations.

(c) NETWORK CHARACTERISTICS.—The Network shall—

(1) be developed jointly with the computer, telecommunications, and information industries;

(2) be designed, developed, and operated in collaboration with potential users in government, industry, and research institutions and educational institutions;

(3) be designed, developed, and operated in a manner which fosters and maintains competition and private sector investment in high speed data networking within the telecommunications industry;

(4) be designed, developed, and operated in a manner which promotes research and development leading to deployment of commercial data communications and telecommunications standards, for such purposes as encouraging the establishment of privately operated high-speed commercial networks;

(5) be designed to ensure the continued application of laws that provide network and information resources security measures that protect copyright and intellectual property rights, or that control access to data bases;

(6) have accounting mechanisms which allow users or groups of users to be charged for their usage of copyrighted materials available over the Network and, where appropriate and technically feasible, for their usage of the Network;

(7) ensure the interoperability of agency and department networks and regional private networks;

(8) be developed by purchasing standard commercial transmission and network services from vendors whenever feasible;

(9) be developed by obtaining customized network services from vendors when it is not feasible to obtain standard services or no such standard services are available; and

(10) support research and development of networking software and hardware.

(d) NATIONAL SCIENCE FOUNDATION RESPONSIBILITY.—Within the Federal Government, the National Science Foundation shall be responsible for managing the Network according to policies established for the Program under section 5(a)(5)(A).

(e) INFORMATION SERVICES.—The Director shall coordinate implementation of the activities of appropriate agencies and departments to promote the development of information services that could be provided over the Network. These services may include the provision of directories of users and services on computer networks, data bases of unclassified Federal scientific data, training of users of data bases and networks, access to commercial information services for users of the Network, and technology to support computer-based collaboration that allows researchers around the Nation to share information and instrumentation.

(f) USE OF GRANT FUNDS.—The National Science Foundation, the National Aeronautics and Space Administration, the Department of Energy, the Department of Defense, the Department of Commerce, the Department of the Interior, the Department of Agriculture, the Department of Health and Human Services, and the Environmental Protection Agency may allow recipients of Federal research grants to use grant funds to pay for computer networking expenses associated with the Program.

SEC. 7. ROLE OF THE NATIONAL SCIENCE FOUNDATION.

(a) GENERAL RESPONSIBILITIES.—As part of the Program described in section 5, the National Science Foundation shall provide computing and networking infrastructure support for all science and engineering disciplines, and support basic research and human resource development in all aspects of high-performance computing and advanced high-speed computer networking.

(b) AUTHORIZATION OF APPROPRIATIONS.—From sums otherwise authorized to be appropriated, there are authorized to be appropriated to the National Science Foun-

dation for the purposes of this Act $213,000,000 for fiscal year 1992; $262,000,000 for fiscal year 1993; $305,000,000 for fiscal year 1994; $354,000,000 for fiscal year 1995; and $413,000,000 for fiscal year 1996.

SEC. 8. ROLE OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.

(a) GENERAL RESPONSIBILITIES.—As part of the Program described in section 5, the National Aeronautics and Space Administration shall conduct basic and applied research in high-performance computing, particularly in the fields of computational aerosciences, earth and space sciences, and remote exploration and experimentation.

(b) AUTHORIZATION OF APPROPRIATIONS.—From sums otherwise authorized to be appropriated, there are authorized to be appropriated to the National Aeronautics and Space Administration for the purposes of this Act $72,000,000 for fiscal year 1992; $107,000,000 for fiscal year 1993; $134,000,000 for fiscal year 1994; $151,000,000 for fiscal year 1995; and $145,000,000 for fiscal year 1996.

SEC. 9. ROLE OF THE DEPARTMENT OF ENERGY.

(a) GENERAL RESPONSIBILITIES.—As part of the Program described in section 5, the Department of Energy shall—

(1) perform technology development and systems evaluation of high-performance computing systems;

(2) conduct computational research with emphasis on energy applications;

(3) conduct gigabit network applications research and develop related software tools; and

(4) support basic research and human resource development in computational science.

(b) AUTHORIZATION OF APPROPRIATIONS.—From sums otherwise authorized to be appropriated, there are authorized to be appropriated to the Department of Energy for the purposes of this Act $93,000,000 for fiscal year 1992; $110,000,000 for fiscal year 1993; $138,000,000 for fiscal year 1994; $157,000,000 for fiscal year 1995; and $168,000,000 for fiscal year 1996.

SEC. 10. ROLE OF THE DEPARTMENT OF COMMERCE.

(a) GENERAL RESPONSIBILITIES.—As part of the Program described in section 5—

(1) the National Institute of Standards and Technology shall conduct basic and applied measurement research needed to support various high-performance computing systems and networks, and, in consultation with other relevant agencies and private industry, may adopt standards and guidelines, and develop measurement techniques and test methods, for the interoperability of high-performance computing systems in networks and for common user interfaces to systems, and shall be responsible for developing benchmark tests and standards for high-performance computing systems and software; and

(2) the National Oceanic and Atmospheric Administration shall conduct basic and applied research in weather prediction and ocean sciences, particularly in development of new forecast models, in computational fluid dynamics, and in the incorporation of evolving computer architectures and networks into the systems that carry out agency missions.

(b) HIGH-PERFORMANCE COMPUTING AND NETWORK SECURITY.—The National Institute of Standards and Technology shall conduct research needed to support the adoption of security standards for high-performance computing systems and networks. In accomplishing this objective, the National Institute of Standards and Technology shall utilize whenever possible recognized centers of expertise that may exist in the academic and national laboratory communities.

(c) STUDY OF IMPACT OF REGULATIONS.—(1) The Secretary of Commerce, in consultation with the Administrator of the Office of Federal Procurement Policy, shall conduct a study to evaluate the impact of Federal procurement regulations which require that contractors providing software to the Federal Government share the rights to proprietary software development tools that the contractors use to develop the software, including a determination of whether such regulations discourage development of improved software development tools and techniques.

(2) The Secretary of Commerce shall, within 1 year after the date of enactment of this Act, report to the Congress regarding the results of the study conducted under paragraph (1).

(d) AUTHORIZATION OF APPROPRIATIONS.—From sums otherwise authorized to be appropriated, there are authorized to be appropriated—

(1) to the National Institute of Standards and Technology for the purposes of this Act $3,000,000 for fiscal year 1992; $3,500,000 for fiscal year 1993; $4,000,000 for fiscal year 1994; $4,500,000 for fiscal year 1995; and $5,000,000 for fiscal year 1996.

(2) to the National Oceanic and Atmospheric Administration for the purposes of this Act $2,500,000 for fiscal year 1992; $3,000,000 for fiscal year 1993; $3,500,000 for fiscal year 1994; $4,000,000 for fiscal year 1995; and $4,500,000 for fiscal year 1996.

SEC. 11. ROLE OF THE ENVIRONMENTAL PROTECTION AGENCY.

(a) GENERAL RESPONSIBILITIES.—As part of the Program described in section 5, the Environmental Protection Agency shall conduct basic and applied research directed toward the advancement and dissemination of computational techniques and software tools which form the core of ecosystem, atmospheric chemistry, and atmospheric dynamics models.

(b) AUTHORIZATION OF APPROPRIATIONS.—From sums otherwise authorized to be appropriated, there are authorized to be appropriated to the Environmental Protection Agency for the purposes of this Act $5,000,000 for fiscal year 1992; $5,500,000 for fiscal year 1993; $6,000,000 for fiscal year 1994; $6,500,000 for fiscal year 1995; and $7,000,000 for fiscal year 1996.

## I. SUMMARY

### BACKGROUND AND NEED FOR LEGISLATION

High-performance computing has become a powerful and indispensable aid to scientific and engineering research, product and process development, and all aspects of manufacturing. Computers can be used to create elaborate mathematical models of the world around us which in turn permit detailed study of how the elements of the models interact in space and time, outside of the limits imposed by the real world. For example, high-performance computers can shrink oceans, zoom in on molecules, slow down physics and fast-forward climates. Understanding comes from seeing natural phenomena at the right size and the right speed.

Another powerful capability of high-performance computing is to easily manipulate enormous quantities of numerical data that arise from scientific and engineering experiments. For example, the Voyager Mission to Neptune produced computer generated pictures that contained more than one trillion bits of data. The proposed mission to Planet Earth will produce in five days, from one satellite platform, data equivalent to the contents of the Library of Congress. Only by means of high-performance computers can this torrent of numbers be translated into visual images that can be interpreted and understood. The computer essentially is the indispensable tool for converting digital information into knowledge.

There is more to high-performance computing than high-performance computers. To allow the scientific and technical community to tap the power of computers and to extract knowledge from enormous data bases requires the existence of a high-capacity, national data network. Such a network will remove geographical constraints on collaboration among scientists, on use of central facilities, such as supercomputers, and on access to specialized data bases. Although all future uses are not yet seen, the implications of a national high-capacity network are not limited to research and development. For example, the Vista Net in North Carolina has been used to send CAT scan images to a remote supercomputer for analysis in order to increase the accuracy of the targeting of a radiation beam used in treating tumors—all in real time.

Establishment of a national network will not involve the laying of wires and cables. Instead, it will consist of the development of a new generation of software and switches which will facilitate the

transmission of data through existing fiber optic cables. The goal of the network is to achieve a dramatic increase in the speed at which data is transmitted from a current ceiling of approximately 1.5 million bits of information per second to more than one billion bits per second and to extend access from the universities, laboratories and hospitals which are currently served by high-performance computer networks to any researcher with a personal computer.

Although much progress has been made in high-performance computing, the time is ripe to accelerate progress through the coordinated, interagency program proposed in the bill. New technological opportunities have arisen in parallel computer architectures, microelectronics, optoelectronics, and software. The high-performance computing R&D community itself has arrived at a consensus on the timeliness of applying and integrating the new computing and networking technologies now emerging in order to attack grand challenge problems in such areas as climate modeling, pollution dispersion, the human genome, materials synthesis, and efficient combustion systems.

Wider application of high-performance computing will boost national productivity and competitiveness across the entire economic front. Computer simulation of industrial products allows determination of performance prior to production, thereby improving product quality and reliability while reducing manufacturing costs. Computer networking has shown promise for expediting ordering and scheduling delivery of goods and services, thereby minimizing inventory costs and production delays. Expert systems will dramatically increase the productivity and effectiveness of professionals in such fields as engineering, finance, medicine, and manufacturing.

To gauge the potential economic benefits of the high-performance computing program on which H.R. 656 is based, the Department of Education contracted a study which was cited by Dr. D. Allan Bromley, the OSTP Director, in a joint hearing before the Subcommittee on Science and the Subcommittee on Technology and Competitiveness. The study predicted a payback from the high-performance computing program in the range from $170 billion to $500 billion over the next decade. Even taking into account the uncertainties in such economic projections, the potential value of the program is evident.

## PURPOSE OF THE BILL

The purpose of the bill is to provide for a focused and coordinated Federal research program in high-performance computing. High-performance computing encompasses the leading edge of computing technologies: the most sophisticated computer chips, the fastest computers with the largest memories, the fastest algorithms, and the fastest computer networks. The program will advance research and development activities in universities, federal laboratories and industry, as well as improve education at all levels.

The bill supports the President's initiative to expand and coordinate R&D activities sponsored by several federal agencies and, in particular, by the National Science Foundation (NSF), the Defense

Advanced Research Projects Agency (DARPA), the Department of Energy (DOE), and the National Aeronautics and Space Administration (NASA). Increased federal funding is authorized for the development and use of new supercomputers, advanced software, and a National Research and Education Network (NREN), a computer network capable of transmitting billions of bits (gigabits) of data per second. The bill also increases support for basic research and the expansion of the human resource base in computer and computational sciences.

This new initiative will be implemented through R&D activities at the principal federal R&D agencies. Responsibility for coordination and planning for the program is assigned to the Office of Science and Technology Policy (OSTP). The roles and responsibilities of the agencies for different aspects of the program are discussed in the 1991 OSTP plan for high-performance computing and communications, which accompanied the President's FY92 budget request. These roles and responsibilities will evolve as the program is implemented.

### BUDGET EXPLANATION

The bill includes five-year authorizations to six agencies: NSF, NASA, DOE, National Institute of Standards and Technology (NIST), National Oceanographic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA). These authorizations are from sums otherwise authorized to these agencies through the usual authorization process. Each agency participating in the high-performance computing program is required by the bill to include a specific funding request for the program in its annual budget submission.

The following amounts are authorized in the bill in millions of dollars:

| | NSF | NASA | DOE | NIST | NOAA | EPA |
|---|---|---|---|---|---|---|
| Fiscal year: | | | | | | |
| 1992 | 213 | 72 | 93 | 3.0 | 2.5 | 5.0 |
| 1993 | 262 | 107 | 110 | 3.5 | 3.0 | 5.5 |
| 1994 | 305 | 134 | 138 | 4.0 | 3.5 | 6.0 |
| 1995 | 354 | 151 | 157 | 4.5 | 4.0 | 6.5 |
| 1996 | 413 | 145 | 168 | 5.0 | 4.5 | 7.0 |

## II. Committee Actions

H.R. 656 was introduced by Representative George E. Brown, Jr. on January 28, 1991. The bill was referred solely to the Committee on Science, Space, and Technology. Within the Committee referral was made to the Science Subcommittee and to the Technology and Competitiveness Subcommittee.

A joint hearing on H.R. 656 before the Subcommittee on Science and the Subcommittee on Technology and Competitiveness was held on March 7, 1991. Witnesses included Senator Albert Gore (D–TN), sponsor of the companion Senate bill to H.R. 656; Dr. D. Allan Bromley, the Director of the Office of Science and Technology Policy (OSTP); Dr. Kenneth King, President of EDUCOM; Dr.

George Johnston, Research Scientist from MIT; Dr. Glenn Ricart, Director of SURANET; Dr. Stewart Personick, Assistant Vice President for Information Networking at Bell Communications Research; Mr. Jim Young, Vice President for Regulation and Industrial Relations at Bell Atlantic; Dr. Paul Young, Professor of Computer Science at The University of Washington; Mr. James Rottsolk, President and CEO of Tera Computer Company; Dr. Greg McRae, Professor of Chemical Engineering at Carnegie Mellon University; and Dr. Larry Lee, Executive Director of the North Carolina Supercomputing Center.

The Administration witness expressed the concerns that the bill, as introduced, overly prescribes the roles of the federal agencies participating in the program and limits flexibility in the program in future years. The non-Federal witnesses expressed unanimous support for the bill and made some suggestions for improvement. The principal recommendation was to ensure that, in formulating and implementing the high-performance computing program, close collaboration occurs between OSTP and the many parts of the private sector which will be involved in the program as R&D performers, suppliers of services, and users of the NREN.

On the basis of suggestions and concerns raised by OSTP, by other witnesses at the March 7 hearing and by other interested groups, the Subcommittee on Science and the Subcommittee on Technology and Competitiveness developed a substitute amendment to H.R. 656. The Subcommittee on Technology and Competitiveness ordered reported the substitute offered by Chairman Valentine on April 10, 1991. The Subcommittee on Science ordered reported a slightly modified verison of the substitute offered by Chairman Rick Boucher on April 17, 1991.

The amendment in the nature of a substitute, which had been developed jointly between the Subcommittee on Science and the Subcommittee on Technology and Competitiveness, made the following principal changes to H.R. 656, as introduced:

In section 4, the authorization for the Federal Government to procure prototype and early production high-performance computing systems was modified (1) to make clear that such systems are "research computers," and (2) to allow agencies to either purchase or lease such systems.

In section 5, the description of the High-Performance Computing (HPC) Program was made a free standing provision rather than an amendment to the OSTP organic act. Submission of the HPC Plan was changed from biennially to annually, starting in FY 93, and the requirement for a separate annual report accompanying the Plan was deleted. The list of subjects required to be addressed by the HPC plan was expanded to include ensuring accessibility to agency data bases and information, and demonstrating use of the national network for educational purposes. The description of security requirements and policies associated with the HPC plan was expanded to require identification of research needed to establish security standards for computers and networks. Finally, the description of the HPC Advisory Panel was modified by naming the relevant

groups from which representatives are to be selected for the HPC Advisory Panel. In addition, language was added requiring the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) to consider the recommendations of the HPC Advisory Panel in developing and updating the HPC plan.

In section 6, the National Research and Education Network (NREN) was required to link institutions in "every State." Specific kinds of agency activities were specified, and the purchase of networking hardware by the Federal Government was prohibited except for research and development purposes. The description of NREN characteristics was modified to reinforce the goal of assuring access by students and educators, as well as by researchers; to strengthen the role of potential NREN users in development and operation of the network; to ensure application of appropriate security measures; and to ensure that charging mechanisms for copyrighted materials are developed. A new provision was added to give NSF responsibility for managing NREN subject to the policies established by FCCSET. The role of FCCSET relative to NREN was modified by requiring FCCSET to establish policies for mangement and access, and to coordinate activities of federal and non-federal entities regarding deployment. Finally, a new subsection on information services associated with NREN was added.

In sections 7 and 8, statements of general responsibilities for NSF and NASA were modified and specific coordinating roles for the agencies were added, consistent with the 1991 OSTP HPC report. Also, the authorization levels for each agency were changed to show the total, rather than the incremental increase, for each year, and the provision was added authorizing the amounts for the HPC program from amounts otherwise authorized for the agencies.

Sections 9 and 11 are new sections added to describe the roles of DOE and EPA in the HPC Program. The descriptions of roles were consistent with the 1991 OSTP HPC report. Five-year authorizations were included for each agency, with the provision that the authorized amounts are from amounts otherwise authorized for the agencies.

In section 10, a statement of general responsibilities was added for the National Oceanic and Atmospheric Administration (NOAA) based on the 1991 OSTP HPC report. A new subsection was added to specify the responsibilities of the National Institute for Standards and Technology (NIST) for interagency coordination, which was consistent with the 1991 OSTP HPC report, and a statement was added to specify NIST's research responsibilities relative to security standards for HPC systems and networks. Finally, five-year authorizations were provided for NIST and NOAA with a provision that the authorized amounts are from amounts otherwise authorized for the agencies.

On May 8, 1991, the full Committee met to markup H.R. 656. A bipartisan amendment in the nature of a substitute, sponsored by Representatives Boucher, Valentine, Brown, Packard, Lewis and Walker, was adopted based on the version of the bill developed by the Subcommittee on Science and the Subcommittee on Technology and Competitiveness. The substitutes addressed some concerns raised by the Administration related to coordination of the HPC Program and to maintaining the flexibility in agency roles for various parts of the Program. The principal changes made by the substitute were to remove specific agency roles for coordination of different portions of the HPC Program, except for NSF's responsibility for management of NREN; to require a detailed annual report describing progress in implementing the Program and updated plans, by subject and by agency, for the next year; to place explicit responsibility for coordinating activities of agencies and departments participating in implementation of the Program with the Director of OSTP; and to clarify the characteristics of the NREN.

## III. Explanation of Committee Amendment

The amendment in the nature of a substitute adopted by the Committee is presented at the beginning of this report.

### NATIONAL HIGH-PERFORMANCE COMPUTING (HPC) PROGRAM

Section 5 of the bill directs the President to implement the HPC Program and requires that the OSTP Director coordinate activities of federal agencies and departments participating in the program. The Committee recognizes the 1991 OSTP report, "Grand Challenges: High-Performance Computing and Communications," as the basic planning document for the HPC Program and expects that annual reports required in section 5 of the amendment will update the basic implementation plan as the program evolves. The Committee anticipates that the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) will continue to be the forum for planning and coordination by the agencies and departments participating in the Program, but this is not mandated, allowing a variety of coordination tools and mechanisms to be employed by the President of the OSTP Director.

In addition to coordination responsibilities, the OSTP Director is required to review agency and department budget estimates for the HPC Porgram, prior to the President's annual budget submission, to ensure consistency with the overall goals and objectives of the Program and to ensure compliance with interagency planning agreements on agency roles and responsibilities. The Director is also required to submit an annual report, at the time the President's annual budget is submitted, which describes the implementation of the Program.

The annual report is expected to provide a comprehensive review of the status of implementation of the HPC Program, an analysis of progress toward achieving Program goals, and a description of any changes in the Program goals and priorities. Descriptions of the activities of the different agencies and departments participating in the Program must be included in the report, along with a breakout of funding levels for the fiscal year in which the report is

submitted and for the fiscal year with respect to which the President's budget submission applies. The funding levels are required to be presented so as to show funding by agency and by activity, including education activities, research activities, hardware and software development, and support for establishment of NREN.

Each agency and department participating in the Program is required to provide each year to the Office of Management and Budget (OMB) a report identifying its high-performance computing activities, including both activities primarily contributing to the Program and activities not part of, but aiding, implementation of the Program. OMB is required to review the reports in light of the plans outlined in the HPC annual report and to include in the President's annual budget estimate a statement showing the allocation of each agency's budget which is part of the HPC Program or aids implementation of the Program.

The amendment requires that the HPC Program define and implement a security plan to protect national computer networks and information resources accessible through national networks. Consistent with the responsibilities NIST was given in the Computer Security Act of 1987 (P.L. 100–235) to establish security standards for federal computer systems that process unclassified, sensitive information, section 5(a)(4) requires that the Program address security standards promulgated by the Secretary of Commerce and contemplates that NIST will be consulted in establishing the security standards in the Program. The Committee expects this consultative process will assure the Program incorporates security standards promulgated by the Secretary of Commerce upon the recommendation of NIST and will satisfy all appropriate requirements.

In order to enable NSF to carry out its management responsibilities for NREN, policies for management and access to NREN are required to be established. The Committee intends that the agencies and departments participating in the Program develop these policies through consensus using the forum of FCCSET and other appropriate interagency mechanisms. The Program is required to be implemented to ensure oversight of the operation and evolution of NREN and to ensure connectivity among computer networks of federal agencies and departments.

Section 5 of the amendment also requires the OSTP Director to establish a High-Performance Computing Advisory Panel to advise him on the content and progress in implementation of the Program. Membership on the Panel is from non-federal experts from a wide range of fields associated with development and use of high-performance computing. Further discussion of the Panel is provided in the Committee Views.

### NATIONAL RESEARCH AND EDUCATION NETWORK (NREN)

Section 6 of the amendment requires establishment of the NREN by the agencies and departments participating in the HPC Program jointly with the private sector. The OSTP Director is responsible for coordination of the agencies' activities, and within the Federal Government, NSF is responsible for managing NREN according to policies established for the Program (See Committee Views).

NERN must be implemented to link research institutions and educational institutions, government, and industry in every state and to provide broad access to researchers, educators and students. The NREN is required to provide users with access to high-performance computing systems, computer data bases, other research facilities and libraries. In general, the Committee intends that NREN provide broadly available access to users and provide for users a wide range of information services, as described in section 6(e) of the amendment.

The amendment requires that NREN be developed jointly with the computer, telecommunications, and information industries. To this end, the agencies are required to purchase standard commercial network services, or customized services if necessary, from vendors; to ensure that NREN development fosters competition and private sector investment in high-speed data networking; and, by promoting development of commercial standards, to encourage establishment of privately operated high-speed commercial networks as an integral part of the NREN. The agencies and departments participating in the Program are prohibited from purchasing networking hardware except for R&D purposes. The NREN is also required to be developed in collaboration with potential users. The Committee expects the Advisory Panel, established by section 5, to provide an important mechanism for obtaining the views of users regarding planning and operation of NREN.

The amendment requires that accounting mechanisms be developed for charging NREN users where appropriate and technically feasible. Also, part of the development of NREN, ways must be determined to protect information, including protection of copyright and intellectual property rights. Accounting mechanisms must be developed to allow charging NREN users for use of copyrighted materials, in accordance with existing law. In section 6(f), several agencies are authorized to allow recipients of federal research grants to use grant funds for networking expenses.

### ROLES OF FEDERAL AGENCIES

Sections 7–11 of the amendment describe general responsibilities of NSF, NASA, DOE, DOC, and EPA in implementing the HPC Program. The amendment provides broad authorities which are intended to give the agencies maximum flexibility in developing their R&D programs. The Committee anticipates that the research activities of the different agencies may change as the HPC Program evolves.

### AUTHORIZATION OF APPROPRIATIONS

Sections 7–11 of the amendment authorize appropriations for NSF, NASA, DOE, NIST, NOAA, and EPA for purposes of implementing the HPC Program. The authorization for each agency is for FY 1992 through 1996 and is from sums otherwise authorized to that agency. The latter provision was included since, according to section 5 of the amendment, each agency participating in the Program must include a separate budget estimate for its contribution to the Program, which is required to be included in the President's annual budget request for that agency. Consequently, the compo-

nents of the HPC Program in each agency's budget will be included in the usual authorization and appropriation bills for the agency.

MISCELLANEOUS PROVISIONS

Section 4(a) excludes all provisions of the amendment, subject to the determination of agency and department heads, from application to classified computer systems.

Section 4(b) is intended to allow agencies and departments participating in the HPC Program to purchase or lease prototype and early production models of new high-performance computing systems and subsystems. In light of the definition in section 3 of the bill, all references to "high-performance computing systems" intend that promising new systems of all types be provided for evaluation and use by scientists and engineers in addressing grand challenge problems. Either purchase or lease of such computing systems was authorized in order to allow the agencies and departments to use either capital or operating funds in obtaining access to the most advanced machines. Finally, the Committee intends this section to apply to acquisition of research computers which would have unique characteristics and would be expected to be acquired in limited numbers of evaluation purposes and to stimulate development of specialized software. Further discussion of high-performance computers and computing systems is included in the Committee Views.

## IV. Sectional Analysis of H.R. 656, as Reported

A bill to provide for a coordinated federal research program to ensure continued United States leadership in high-performance computing.

Section 1 is the title of the bill.

Section 2 contains findings and purpose of the bill.

Section 3 contains definitions of terms in the bill.

Section 4 contains provisions to make clear that computer systems for classified information are not affected by this bill. In addition, federal agencies participating in the program are authorized to purchase or lease prototype and early production models of new high-performance computer systems.

Section 5(a) requires the President to implement a National High-Performance Computing (HPC) Program. The Director of OSTP is required to (1) submit an annual report at the time of the President's budget submission describing implementation of the HPC Program; (2) provide for interagency coordination of the implementation of the Program; (3) review agency budget estimates, prior to submission of the annual report, in the context of the Program and make the results of the review known to the Office of Management and Budget; and (4) consult with non-federal entities involved in high-performance computing. The annual report must describe the planning and implementation of the HPC Program, including activities and funding levels by research area and by agency. The HPC Program must address security issues to protect national networks and information resources available through networks, and define and implement a security plan. The HPC Program must also establish policies for management and access to the

National Research and Education Network (NREN), provide oversight for operation of RNEN, and ensure connectivity among agency computer networks.

Section 5(b) creates a High-Performance Computing Advisory Panel (Panel), consisting of individuals from the private sector, to provide the Director with advice and information on high-performance computing. The Director is required to consider recommendations of the Panel in developing and revising the Program.

Section 5(c) requires each agency participating in the HPC Program to designate in its budget request to OMB the program elements supporting the Program. OMB is required to review the agencies' budget requests in light of the annual report and to provide with the President's budget submission to Congress a breakout of agency programs supporting the Program.

Section 6(a) requires that the OSTP Director coordinate implementation of agency activities in supporting deployment and use of NREN to link research and educational institutions, government, and industry in every State. Agency activities are broadly specified, and agencies are prohibited from purchasing networking hardware except for R&D purposes.

Section 6(b) requires broad access by researchers, educators, and students to NREN and requires NREN to provide access for users to computers and other research facilities, data bases, and libraries. Also, to the extent practicable, NREN is required to provide access to information resources maintained by libraries, research facilities, publishers and affiliated organizations.

Section 6(c) specifies the characteristics of NREN to include (1) development jointly with industry and in collaboration with potential users, (2) fostering competition and private sector investment, (3) promoting deployment of commerical standards, (4) protection of intellectual property rights and maintenance of security, and (5) development of accounting mechanisms to allow for charging of users, (6) interoperability of agency networks and regional private networks, (7) purchasing standard, or if necessary customized, services from commercial vendors, and (8) support for research and development of networking hardware and software.

Section 6(d) designates NFS to manage NREN according to policies established for the HPC Programs.

Section 6(e) requires the Director to coordinate implementation activities of appropriate agencies to promote development of information services available over NREN and defines the kinds of services that may be provided.

Section 6(f) authorizes specific agencies to allow federal research grant funds to be used to pay for computer networking expenses.

Section 7(a) defines general responsibilities of NSF for providing computing and networking infrastructure support and for supporting basic research and human resource development in all aspects of high-performance computing and networking.

Section 7(b) authorizes the following amounts for NSF for the HPC Program from sums otherwise authorized (in millions of dollars):

| Fiscal year: | |
|---|---|
| 1992 | 213 |
| 1993 | 262 |

| | |
|---|---|
| 1994 | 305 |
| 1995 | 354 |
| 1996 | 413 |

Section 8(a) defines general responsibilities of NASA for conducting research in high-performance computing in fields related to the agency's mission.

Section 8(b) authorizes the following amounts for NASA for the HPC Program from sums otherwise authorized (in millions of dollars):

| Fiscal year: | |
|---|---|
| 1992 | 72 |
| 1993 | 107 |
| 1994 | 134 |
| 1995 | 151 |
| 1996 | 145 |

Section 9(a) defines general responsibilities of DOE for development and evaluation of computing systems, computational research, gigabit network applications research, and support of basic research and human resource development in computational science.

Section 9(b) authorizes the following amounts for DOE for the HPC Program from sums otherwise authorized (in millions of dollars):

| Fiscal year: | |
|---|---|
| 1992 | 93 |
| 1993 | 110 |
| 1994 | 138 |
| 1995 | 157 |
| 1996 | 168 |

Section 10(a) defines general responsibilities of NIST for standards development and test methods for interoperability of computers in networks and for benchmark tests and standards for high-performance computers and software. Also, general responsibilities are defined for NOAA for research in high-performance computing related to the agency's mission.

Section 10(b) requires NIST to conduct research to support adoption of security standards for high-performance computer systems and networks.

Section 10(c) requires the Security of Commerce, in consultation with the Administrator of the Office of Federal Procurement Policy, to conduct a study and report to Congress on the effect of federal procurement regulations regarding federal rights to proprietary software development tools used by contractors in federal software procurements.

Section 10(d) authorizes the following amounts for NIST and NOAA for the HPC Program from sums otherwise authorized (in million of dollars):

| | Fiscal year— | | | | |
|---|---|---|---|---|---|
| | 1992 | 1993 | 1994 | 1995 | 1996 |
| NIST | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| NOAA | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 |

Section 11(a) defines general responsibilities of EPA for conducting research in high-performance computing in fields related to the agency's mission.

Section 11(b) authorizes the following amounts for EPA for the HPC Program from sums otherwise authorized (in millions of dollars):

| Fiscal year | |
|---|---|
| 1992 | 5 |
| 1993 | 5.5 |
| 1994 | 6 |
| 1995 | 6.5 |
| 1996 | 7 |

## V. Committee Views

### 1. HIGH-PERFORMANCE COMPUTERS AND COMPUTER SYSTEMS

*Background*

Federal support for computing dates back to the development of the earliest digital computers during World War II. Publication of R&D results from this and the immediate post-war periods and movement to the private sector of scientists and engineers who had participated in the federally funded projects led to the development of the first civilian computers at Remington Rand.

As the fledgling computer industry developed and grew, the federal role shifted to R&D support of the more exotic classes of machines and software, particularly supercomputers. This role has continued to the present with DARPA's support of development of new classes of high-performance computers which employ hundreds to thousands of processing elements and which have been termed massively parallel computers.

Federal R&D support has led to breakthroughs in technology over the entire history of the computer industry. Equally important to the industry has been the federal practice of procuring prototype and early production models of new types of machines for installation in federal laboratories. This practice has provided revenue streams to help the industry to sustain further product development and has led to the generation of applications software tailored to the new machines, which in turn has helped to stimulate computer sales.

*Committee View*

The Committee intends that reference to "high-performance computing systems" in the bill encompass current and new generations of scientific workstations, current and future vector supercomputers, special purpose and experimental computers, and large scale parallel computer systems developed both in the private and public sectors. Likewise, the Committee intends for support for applications software development within the high-performance computing program to involve software technologies applied to both current and future generations of hardware, as appropriate for particular grand challenge problems.

In section 4 of the bill, the Committee authorizes continued purchase and lease of prototype and early production models of high-performance computing systems and subsystems by federal agen-

cies, consistent with particular agency roles under the HPC Program. For these special types of computers, agencies are authorized to use acquisition regulations applicable for research computers and to install these computers in federal or non-federal laboratories, so as to provide maximum access by researchers.

A distinction must be made between the purchase of a single prototype supercomputer by other means than full, fair and open competition, and the purchase of multiple systems without competition. This bill is intended to limit government agencies from using funds provided under this legislation to purchase more than one or two initial prototypes of a particular computer, unless the provisions of procurement law requiring full, fair and open competition are satisfied. It is the intent of this legislation that purchase or lease of other prototypes shall be competitive within the limits posed by U.S. national security and industrial mobilization efforts. Products which result from governmental subsidized development are required to compete for acceptance among government agencies, contractors and grantees, on competitive terms with products offered without subsidized development by private industry. In this regard, the last sentence in Section 4(b) permitting all equipment acquired under this section to be considered research computers for purposes of applicable acquisition regulations does not diminish the intent for full, fair and open competition in the actual acquisition of equipment, keeping in mind the necessity of developing a strong U.S. based supercomputer industry.

### 2. HIGH-PERFORMANCE COMPUTING SOFTWARE

*Background*

Applications software for high-performance computers traditionally has been developed by scientists and engineers seeking solutions to specific problems rather than by the companies which developed the hardware. Software design and development is a labor-intensive, hand-crafted process, and the computer programs produced are usually optimized for specific machines. The vast majority of effort on development of high-performance computing software has been for general purpose supercomputers which typically employ vector processors. This category of supercomputers is currently the primary tool for the most challenging computational science and engineering applications. But even with twenty years of software development, there is in general a shortage of portable, general purpose software for scientific and engineering applications. Moreover, for the emerging highly parallel computers, a significant investment will be needed in operating systems, software design tools, and software to support development of application programs to harness the potential computational power of these machines.

*Committee View*

The Committee strongly believes that a major goal of the HPC Program is to stimulate research on software technology in order to improve software productivity, capability, portability and reliability. The Committee expects applications software development efforts to be focused on grand challenge problems and to encompass

the full range of high-performance computers, including vector computers, the most promising highly parallel computers, and hybrid systems. The Committee also believes additional efforts are needed to document and evaluate software for research and educational applications.

The Committee emphasizes the importance of providing the widest possible access for scientists and engineers to all categories of high-performance computing systems, including the most promising novel architectures, in order to speed the development of applications software and to evaluate the capabilities of different computer architectures for problems of scientific and technical interest. The Committee encourages federal agencies and departments, State and local governments, industries and universities to exchange unclassified software in the public domain. The Committee considers software development to be a key component of a balanced HPC Program, and supports all aspects of its advancement.

### 3. A COORDINATED, INTERAGENCY PROGRAM FOR HIGH-PERFORMANCE COMPUTING

*Background*

In Public Law 99-383, the Office of Science and Technology Policy (OSTP) was required to report to Congress on needs and options regarding communication networks for research computers at universities and federal research facilities. A subcommittee of the OSTP Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) undertook this task and expanded it to encompass national needs regarding all aspects of research and development in high-performance computing. OSTP reports released in 1987 and 1989 outlined a five-year initiative to augment federal R&D in the areas of computer hardware, software technology and algorithms, networking, and basic research and human resource development.

The initiative described in the OSTP reports grew out of intensive discussions among the principal federal R&D agencies which sponsor research in high-performance computing. The process included a series of workshops to seek out the views of experts from industry, academe, and government in formulating the objectives and scope of the initiative.

The President's budget request for FY 1992 included an interagency R&D program in high-performance computing and communications. A report prepared by OSTP, "Grand Challenges: High Performance Computing and Communications", which accompanied the budget, describes specific program objectives and budget allocations for each of the several federal agencies participating in the program.

*Committee View*

The Committee believes that the process begun by FCCSET to initiate the high-performance computing and communications program should be the model for developing the High-Performance Computing (HPC) Program required by H.R. 656. The OSTP report released with the President's FY 1992 budget submission is viewed as the initial plan for the Program called for in section 5 of the

bill. The Committee expects the Program to change with time and for the agencies' programs to have the flexibility to change as dictated by evolution of the technology and as necessary to exploit unexpected research opportunities. The Committee expects changes in overall Program direction and in agency roles and Program activities to be documented in the annual report.

The bill assigns to the OSTP Director the responsibility to coordinate the interagency implementation of the Program. This function is particularly important because the Program will encompass a broad range of objectives across several agencies. The Committee notes that an important organizing principle for the HPC Program is the focus on grand challenge research problems. Progress in these complex research areas will require balanced support for all of the components of the Program: the network, computer hardware developments, improved software and algorithms, and basic research and human resource development. The Committee intends that the Director monitor program implementation by the agencies to ensure progress among all of the major components of the program plan.

Section 5 of the bill also requires the Director to consult with non-federal entities conducting research on and using high-performance computing. The Committee expects that much of this requirement will be met through interactions among the Director, the agencies, and the High-Performance Computing Advisory Panel, established by the bill.

#### 4. THE HIGH-PERFORMANCE COMPUTING ADVISORY PANEL

*Background*

Over the past several years the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) has been active in planning for a high-performance computer R&D initiative. Although FCCSET is composed only of representatives from federal departments and agencies, the planning process has included various workshops and informal advisory panels which have included representatives from industry, academia and other parts of the private sector. Providing mechanisms for obtaining needed expertise from non-federal scientists and engineers and for incorporating the views of groups which will be R&D performers, suppliers of services, and users of the network is necessary to ensure the ultimate success of the HPC Program.

The bill establishes a High-Performance Computing Advisory Panel (Panel) to provide the Director with an independent assessment of various aspects of the HPC Program, including progress in implementation, need for revision, and balance among components. The Panel includes representatives from the private sector, the research, education and library communities, network providers, and industry, who are especially qualified to provide the Director with advice and information on high-performance computing.

*Committee View*

The Committee affirms the importance of obtaining a broad based consensus for the development and implementation of the HPC Program. Membership of the Panel, which includes represent-

atives from the research, education and library communities, and network providers, will ensure that a wide range of views are obtained. The Committee interprets "library communities" to include university, state, regional or local libraries, and "network providers" to include firms that operate or manage fiber optic networks or satellite links, or produce and provide supercomputer and high-end switching services.

The Committee notes that the bill requires the Director to consider the Panel's recommendations in reviewing and revising the Program prior to submission of the annual report called for in section 5 of the bill. The Commmittee expects the Director to introduce the views of the Panel into the interagency deliberations regarding the HPC Program. The role of the Panel will strengthen the relationship between the policy makers and the user/provider communities, foster cooperation, and assist in the rapid development of a user friendly national network.

### 5. CHARACTERISTICS OF THE NATIONAL RESEARCH AND EDUCATION NETWORK (NREN)

*Committee View*

The Committee intends for the National Research and Education Network (NREN) to be designed, developed and operated so as to support a wide range of research and educational activities, to provide high-capacity connections in every state, and to provide access to a wide range of users. The Committee also stresses the importance of close collaboration between the federal agencies implementing the plan for the NREN and the users and suppliers of services in the private sector.

The establishment of NREN will required a joint effort by the Federal Government and the private sector. Further, the Committee expects NREN to evolve so that the role of the private sector increases. The Committee expects the establishment of NREN to be achieved through the purchase of telecommunications services from commercial vendors in a manner similar to that of predecessor networks, such as NSFNET and ARPANET. The bill requires that the process for deploying NREN maintain and encourage competition and private sector investment in high-speed data networking within the telecommunications industry. Also, the bill expressly limits to research and development purposes the purchase of switches, optical fiber, or any other networking hardware by the Federal Government in support of the NREN. The installation of local area networks at federal facilities is not prohibited.

An important aspect of the planning process for NREN is to devise effective mechanisms for providing operating funds for maintenance and use of NREN. The Committee expects attention to be given to developing accounting schemes to allow NREN users to be charged, where appropriate and technically feasible. In formulating possible charging policies, consideration should be given to the importance of maintaining access to NREN for research and education purposes by users who may not be recipients of Federal research grants or contracts. Therefore, provision for low-cost, predictable network access should be included in the future evolution

of NREN to ensure that, for example, schools and libraries are not excluded.

### 6. MANAGEMENT OF THE NATIONAL RESEARCH AND EDUCATION NETWORK (NREN)

*Committee View*

Section 6(d) of the bill assigns to NSF management responsibility, within the Federal Government, for the National Research and Education Network (NREN). The Committee intends that, in carrying out this provision, NSF follow the policy guidance developed for the HPC Program through interagency consensus, arrived at by using coordination mechanisms available to the OSTP Director. Moreover, the Committee expects the views of the High-Performance Computing Advisory Panel to be considered in developing the policy guidance. The actual day-to-day management arrangement to be created for NREN is not specified. The bill simply designates NSF to be responsible for putting an effective structure in place and ensuring that it functions properly.

The Committee expects several agencies, in addition to NSF, to be involved in establishing NREN. All of the agencies represented on the FCCSET Committee on Physical, Mathematical, and Engineering Sciences are expected to work together to set policy guidance for management and access to NREN and, generally, to oversee the operation and evolution of NREN. The Committee does not intend that NSF be other than coequal with each agency participating in the HPC Program in setting policy for NREN, nor does the Committee intend that NSF should have management responsibilities for special limited access networks that may be sponsored by individual agencies to support their mission requirements.

### 7. INFORMATION SERVICES ON THE NATIONAL RESEARCH AND EDUCATION NETWORK (NREN)

*Committee View*

The OSTP Director is charged in the bill with coordinating the activities of federal agencies and departments in promoting the development of information services that could be provided by NREN. The intention is that both federally generated, unclassified data bases, as well as data bases and services from private sector sources be included. The bill also requires that NREN have accounting mechanisms to allow charging for use of copyrighted materials. The Committee stresses the importance of protection of copyright in order to attract data base publishers and other private sector information providers to make products and services available on NREN. The Committee expects copyright protections for authors and publishers to be balanced with the rights of users of copyrighted material, including provision for fair use of copyrighted works for teaching, scholarship or research.

The types of unclassified federal data bases available on NREN are not specified in the bill except for scientific data bases, which in general are intended to be accessible. The bill neither requires nor forbids any agency or department to develop or disseminate to the public any particular information product or service. The Com-

mittee expects information services to be provided by agencies in accordance with applicable federal statutes, regulations and directives governing information dissemination activities.

The Committee notes the important role libraries play in assisting users with access to information and observes that the skills of librarians in organizing and finding information will be important for ensuring that students, small businesses, independent researchers and others are able to access resources on NREN. The Committee strongly encourages the agencies participating in the HPC Program to include libraries in plans for information dissemination on NREN, particularly as access points to NREN and in demonstration projects for providing information resources.

### 8. ROLE OF SUPERCOMPUTING CENTERS

*Background*

Centers of special expertise in computational science and engineering currently exist within the Department of Energy National Laboratories, at the NSF National Supercomputer Centers, at some NASA Research Centers, and at major university and state supported supercomputer centers. These centers have leading edge facilities and highly qualified staffs to support research activities by university, government and industrial scientists and engineers working on a broad range of grand challenge problems. These centers have made contributions in hardware development, applications and systems software, interpretive visualization packages, as well as in outreach to industrial and academic computational researchers.

*Committee View*

The Committee recognizes the contributions federal, university-based, and state centers of expertise have made to advancing high-performance computing and also the capabilities that now reside in the centers. The Committee urges the federal agencies, in implementing the HPC Program, to identify the most capable supercomputing centers and to utilize fully the capabilities of these centers, particularly in regard to addressing grand challenge problems. The most capable centers would be appropriate sites for placement of prototype and early production high-performance computing systems and, in general, should be periodically upgraded with the most advanced computing technologies available so as to ensure adequate access and technical support to scientists and engineers working on grand challenge problems.

## VI. Legislative History

During the 101st Congress, Representative Doug Walgren introduced H.R. 3131, The National High-Performance Computing Technology Act, which was a companion to S. 1067 introduced by Senator Albert Gore. The broad objectives and many detailed provisions of the bill are similar to H.R. 656. Hearings on H.R. 3131 were held on March 14 and 15, 1990 with witnesses from the Administration, the telecommunications and computer industries, academe, and the library and publishing communities. No action was taken on the bill in the House.

In the Senate, hearings were held on S. 1067 on June 21, July 26 and September 15, 1989. The Commerce, Science, and Transportation Committee adopted an amendment in the nature of a substitute and ordered the bill reported on April 3, 1990. S. 1976, the DOE High-Performance Computing Act, was introduced by Senator J. Bennett Johnston on November 21, 1989. A hearing on the bill was held on March 6, 1990, and the Energy and Natural Resources Committee ordered the bill reported on June 27, 1990. A compromise version of the two Senate bills was worked out between the two Committees and passed by the Senate on October 24, 1990. No further action was taken in the 101st Congress.

In the 102nd Congress, Representative George E. Brown, Jr., introduced H.R. 656, the High Performance Computing Act of 1991 on January 28, 1991. A companion bill, S. 272, was introduced by Senator Gore on January 24, 1991. A third bill, S. 343, the DOE High-Performance Computing Act of 1991, was introduced by Senator Johnston on February 5, 1991.

A hearing on H.R. 656 was held on March 7, 1991 and an amendment in the nature of a substitute was adopted and ordered reported on May 8, 1991 (see Committee Actions).

## VII. Committee Oversight Findings and Recommendations

Pursuant to rule XI, clause 2(l)(3) of the Rules of the House of Representatives, under the authority of rules X, clause 2(b)(1) and clause 3(f), the Committee's oversight findings and conclusions are reflected in the recommendations found in the present bill and report.

## VIII. Oversight Findings and Recommendations by the Committee on Government Operations

No statement of findings and recommendations on oversight activity pursuant to rule X, clause 2(b)(2), and rule XI, clause 2(l)(3), of the Rules of the House of Representatives, have been submitted by the Committee on Government Operations for inclusion in this report.

## IX. Congressional Budget Office Cost Estimate

U.S. Congress,
Congressional Budget Office,
*Washington, DC, May 15, 1991.*

Hon. George E. Brown, Jr.,
*Chairman, Committee on Science, Space, and Technology,*
*House of Representatives, Washington, DC.*

Dear Mr. Chairman: The Congressional Budget Office has prepared the attached cost estimate for H.R. 656, the High-Performance Computing Act of 1991. Enactment of H.R. 656 would not affect direct spending or receipts. Therefore, pay-as-you-go procedures would not apply to the bill.

If you wish further details on this estimate, we will be pleased to provide them.

Sincerely,

ROBERT F. HALE
(For Robert D. Reischauer, Director).

CONGRESSIONAL BUDGET OFFICE COST ESTIMATE

1. Bill number: H.R. 656.

2. Bill title: The High-Performance Computing Act of 1991.

3. Bill status: As ordered reported by the House Committee on Science, Space, and Technology on May 8, 1991.

4. Bill purpose: H.R. 656 would require the President to develop and implement a National High-Performance Computing Program. It would also mandate that the Director of the Office of Science and Technology Policy coordinate implementation among the National Science Foundation (NSF), the Department of Defense, the National Aeronautics and Space Administration (NASA), and other relevant federal agencies of a national network of high-speed computers, which would be known as the National Research and Education Network (NREN). The National Institute of Standards and Technology, a part of the Department of Commerce, would be charged with developing government-wide standards for computer networks.

The requirements of H.R. 656 would affect numerous federal agencies as developers and users of the NREN. For example, the bill would require the NSF to manage the network and provide computing and networking infrastructure support. The NSF, NASA, the Department of Energy (DOE), the National Oceanic and Atmospheric Administration (NOAA), and the Environmental Protection Agency (EPA) would be charged with conducting and supporting basic research in all aspects of high-performance computing and networking, and applied research relevant to their disciplines. The Secretary of Commerce would be directed to conduct a study of the impact of federal procurement regulations regarding the rights to proprietary software provided by contractors.

To fund development of the network and high-performance computing research, the bill would authorize appropriations to the NSF, NASA, the Department of Commerce, EPA, and DOE of about $2.9 billion over five years. The bill would also authorize NSF to charge a fee for use of the system.

5. Estimated cost to the Federal Government:

[By fiscal year, in millions of dollars]

| | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| Authorizations: | | | | | |
| National Science Foundation | 213 | 262 | 305 | 354 | 413 |
| National Aeronautics and Space Administration | 72 | 107 | 134 | 151 | 145 |
| Department of Energy | 93 | 110 | 138 | 157 | 168 |
| Department of Commerce | 6 | 7 | 8 | 9 | 10 |
| Environmental Protection Agency | 5 | 6 | 6 | 7 | 7 |
| Total authorization level | 389 | 491 | 591 | 677 | 743 |
| Estimated outlays | 182 | 387 | 518 | 617 | 693 |

In addition to the funding specifically authorized in the bill, other agencies would incur costs to implement the bill's objectives. The bill has adopted goals and strategies for the program that are roughly in line with proposals from the Administration, as reported by the Office of Science and Technology Policy and proposed in the 1992 President's budget. Some of the activities mandated by the bill are already underway.

The President's budget proposed 1992 funding increases totaling $149 million for high-performance computing and communications. This includes $49 million for the Defense Advanced Research Projects Agency (DARPA), for which the bill does not provide specific authorizations. DARPA's five-year funding needs above the 1991 program levels could be $700 million to $800 million, which would result in total DARPA spending for these purposes of $1.7 billion to $1.8 billion over the 1992–1996 period.

The costs of the specific authorizations would be in budget functions 250, 270, 300, and 370. Other significant costs would fall in function 050.

*Basis of estimate:* This estimate assumes that the full amounts authorized would be appropriated for each fiscal year. The estimated outlays are based on historical spending patterns.

CBO expects that fees for use of the network would be phased in once the network is operating, which would probably be in 1994 or later. Receipts from these fees could ultimately provide a significant offset to the operating costs of the network. Nevertheless, we do not expect that receipts would be significant during the five-year period covered by this estimate.

6. Pay-as-you-go considerations: The Budget Enforcement Act of 1990 sets up pay-as-you-go procedures for legislation affecting direct spending or receipts through 1995. CBO estimates that enactment of H.R. 656 would not affect direct spending or receipts. Therefore, pay-as-you-go procedures would not apply to the bill.

7. Estimated cost to State and local governments: None.

8. Estimate comparison: None.

9. Previous CBO estimate: On April 5, 1991, the Congressional Budget Office transmitted a cost estimate of S. 272 as ordered reported by the Senate Committee on Commerce, Science, and Transportation on March 8, 1991. S. 272 is quite similar to H.R. 656 in that both bills would establish a high-performance computing program and a high-speed network. The general scope and direction of both bills for program development is likewise similar. S. 272 did not include authorizations for DOE, EPA, or NOAA, and the authorizations for the remaining agencies, at about $1 billion over the five years, was much lower than in H.R. 656.

10. Estimate prepared by: David Hull, Peter Fontaine, Kim Cawley, and Marjorie Miller.

11. Estimate approved by: C.G. Nuckols, for James L. Blum, Assistant Director for Budget Analysis.

## X. Impact on Inflation

In accordance with rule XI, clause 2(l)(4), of the Rules of the House of Representatives, this legislation is assessed to have no ad-

verse inflationary effect on prices and costs in the operation of the national economy.

## XI. Committee Recommendation

A quorum being present, the bill was ordered reported on May 8, 1991, by a Voice vote of the Committee.

## XII. Changes in Existing Law Made by the Bill, as Reported

In compliance with clause 3 of rule XIII of the Rules of the House of Representatives, no changes in existing law are made by the bill.

## XIII. Additional View

This bill is an important step to advance our lead in high-performance computing. It is a strategic approach to a specific emerging technology, and is an example of the new strategies we should be using as part of a Marshall Plan for America to stimulate our own economic growth.

The United States has been losing its competitive edge in several areas of high technology, and our technological infrastructure has slipped badly in several important fields. I have been calling for a Marshall Plan for America to develop strategies for ourselves as appropriate for our needs as those we employed with such success in rebuilding Europe and Japan after World War II. Maintaining our lead in high-performance computing should be part of such a strategy.

Ray Thornton.

○